

**Climate model simulations and observations** are both *approximations* of the “truth”, however, observational uncertainties are mostly ignored (seen as minor) in their inter-comparison.

**Selection of observations** is rarely guided by objective criteria and relies often on data accessibility and institutional proximity

Uncertainty estimates provided by the products is often ignored (exceptions: data assimilation), partly because of the lack of **verification concepts that account observational uncertainty** and guidance in **uncertainty propagation**

CMUG is an unique platform to bring the modelling and observational community together **towards a joint uncertainty assessment of climate information**

Some examples from seasonal forecasting carried out in VERITAS-CCI:

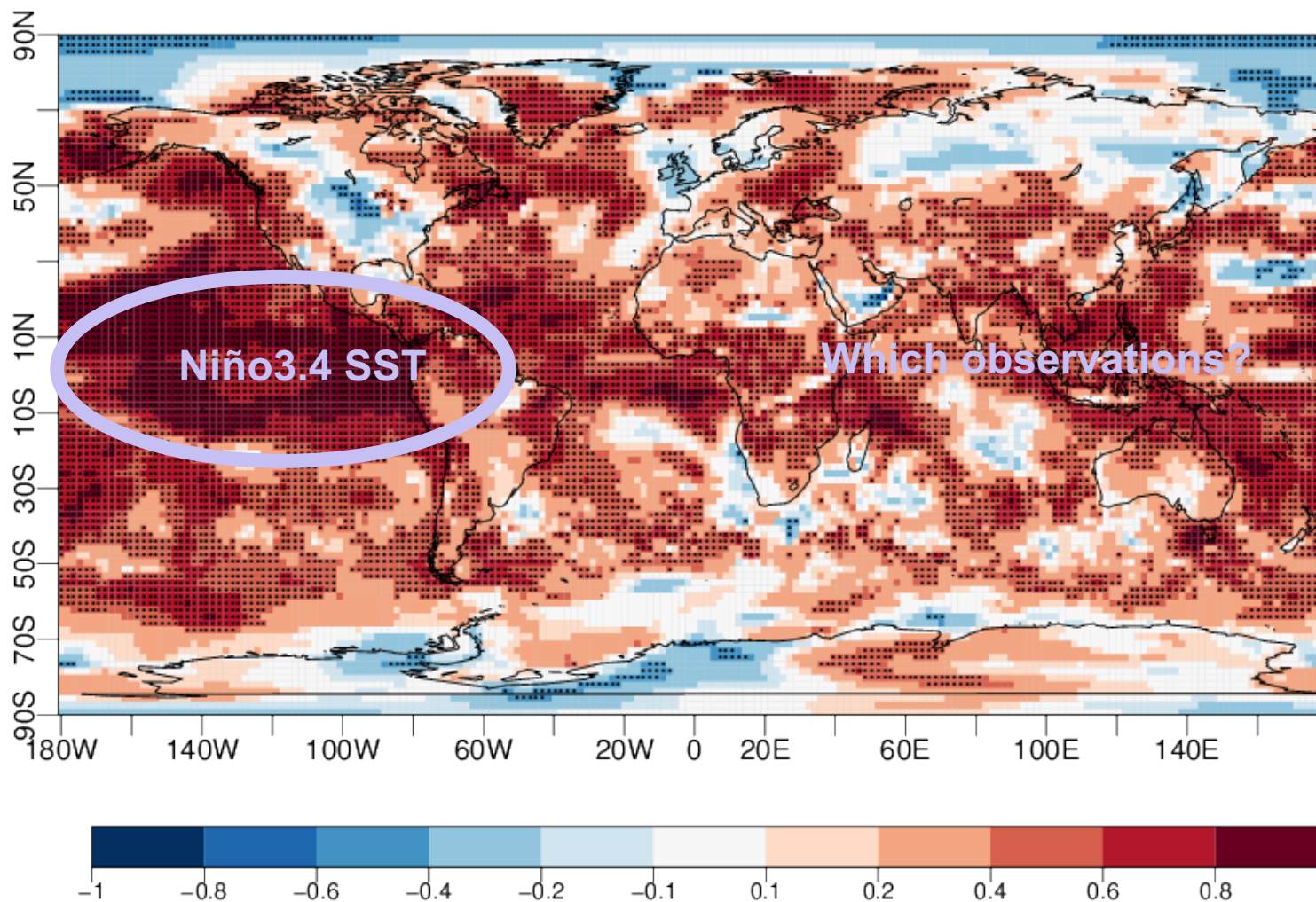
- How relevant is the observational uncertainty compared to model uncertainties?
- How can we use observational uncertainty estimates from CCI in the modelling community for verification?
- Can the quality of observational datasets be assessed using climate models?

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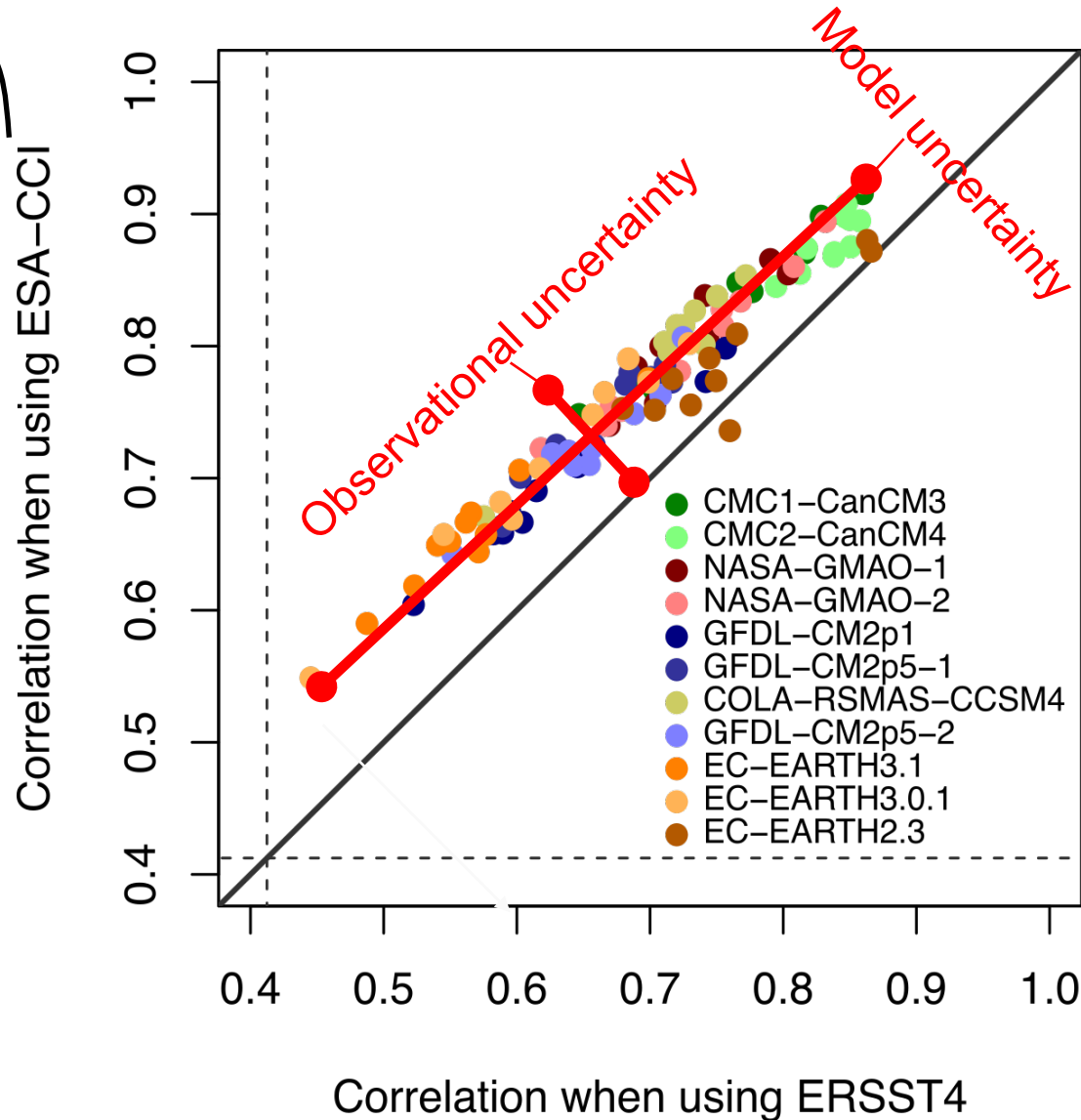
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## Summer seasonal forecast skill: EC-Earth3 (T511ORCA0.25)



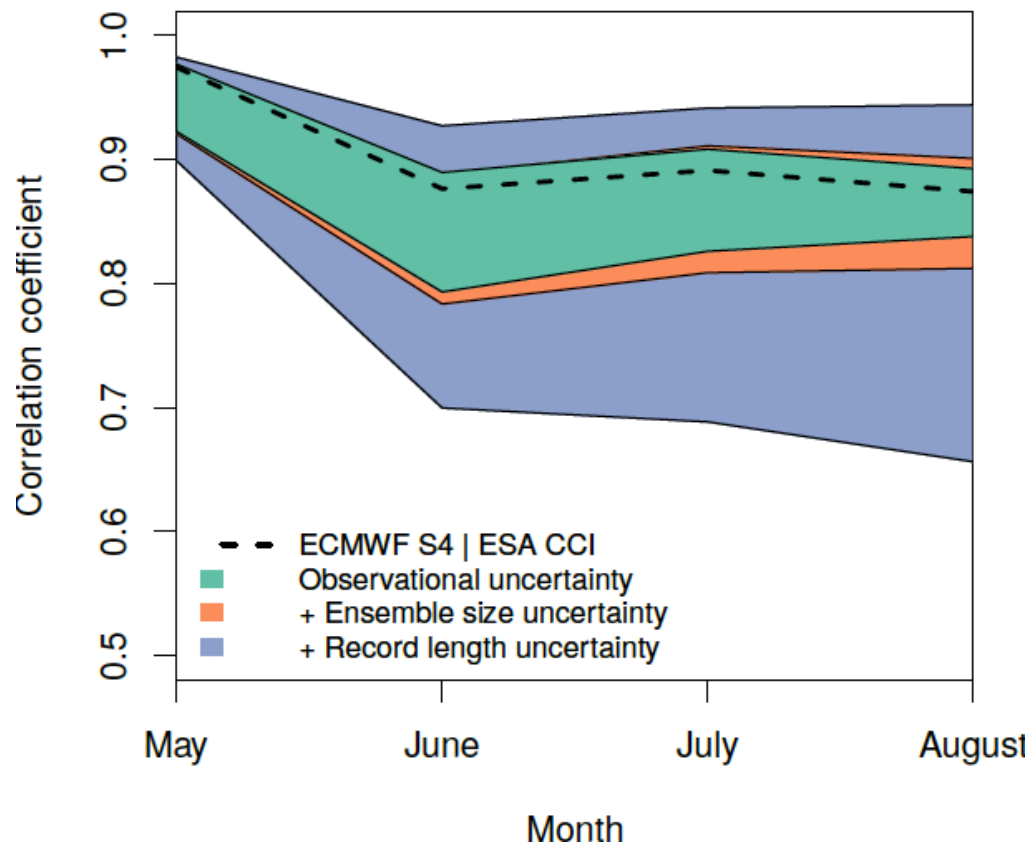
# Acknowledging joint uncertainty

Independent  
from the  
models



## Comparison to sample uncertainties: observational uncertainty is an important source of verification uncertainty for ENSO

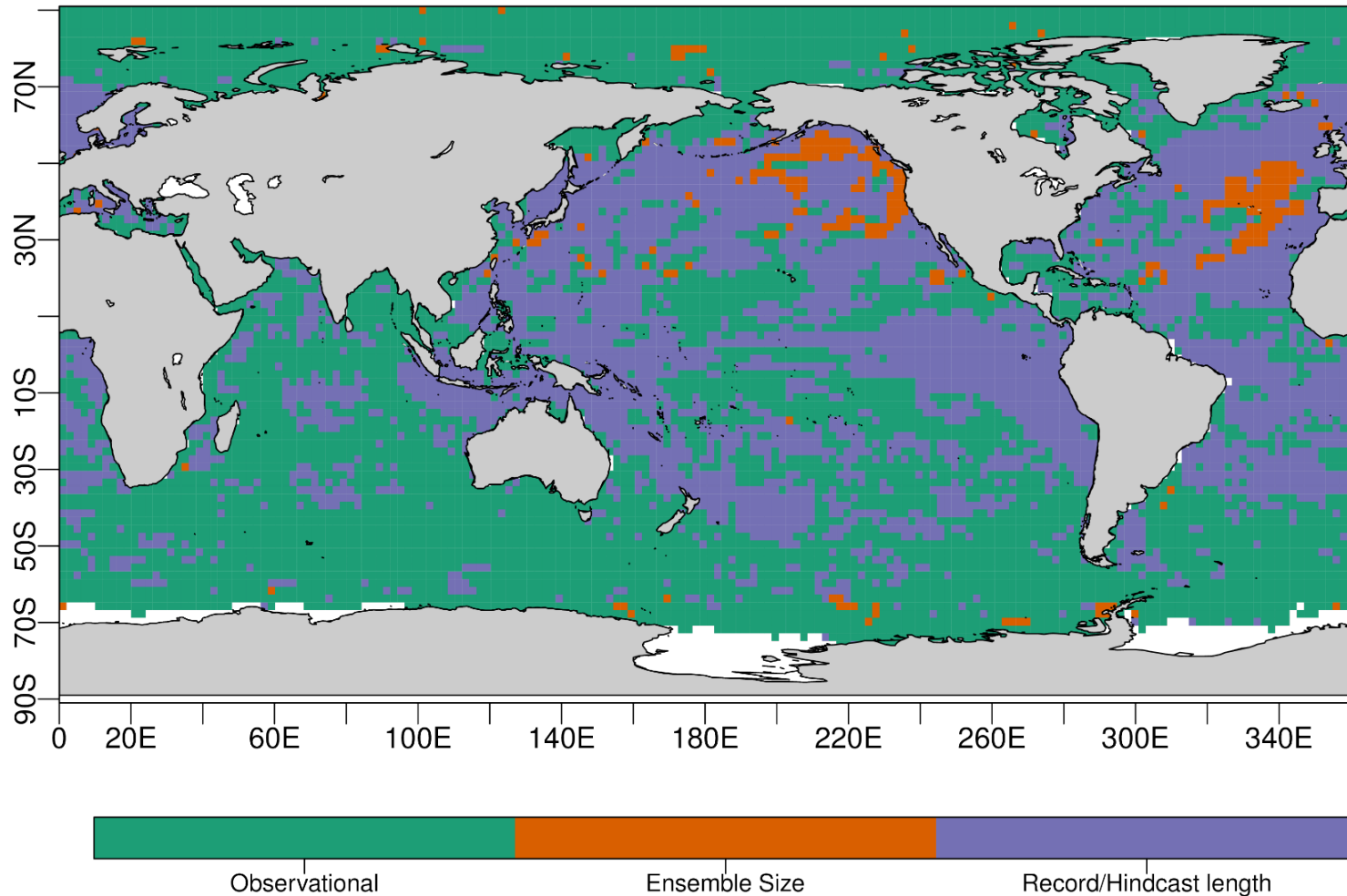
Prediction skill ENSO



observational uncertainty  
model ensemble size  
length of the verification  
period

**Verification at high-latitudes is limited by observational uncertainty.**

**Dominating source of verification uncertainty**



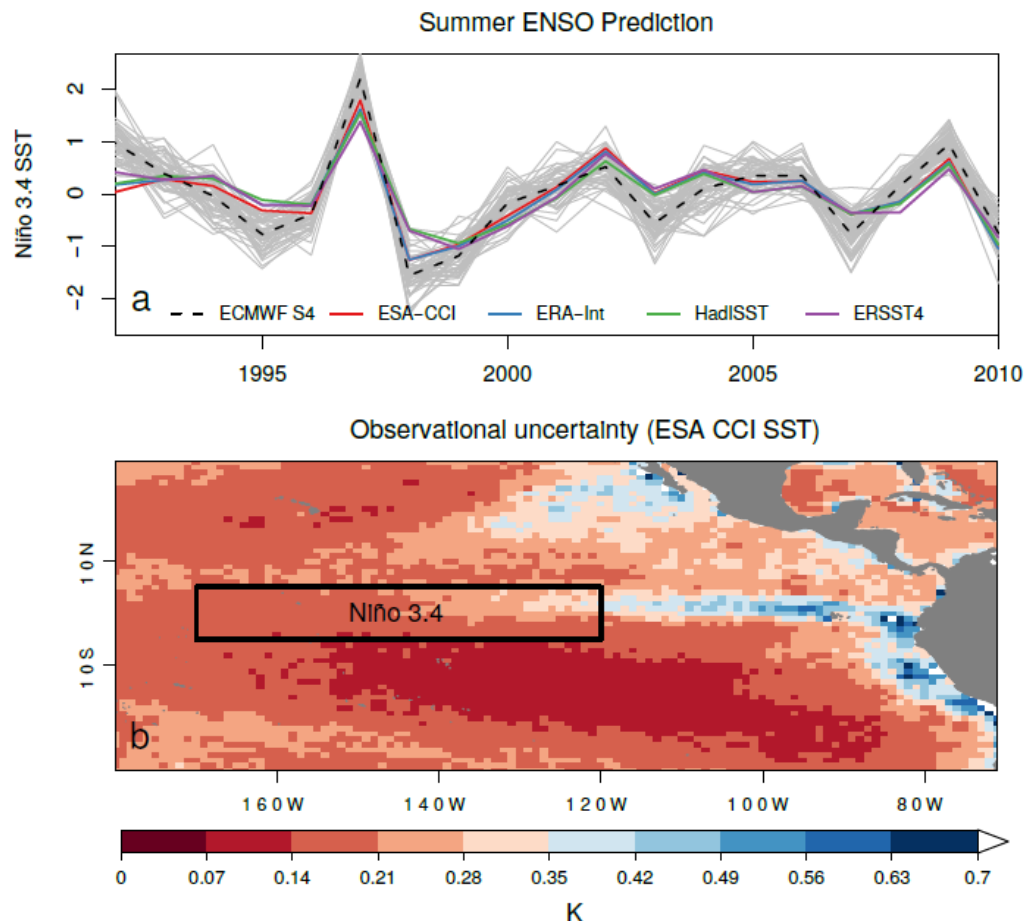
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**Model evaluation often requires spatial and temporal averaging,  
requires the consideration of error correlation scales**



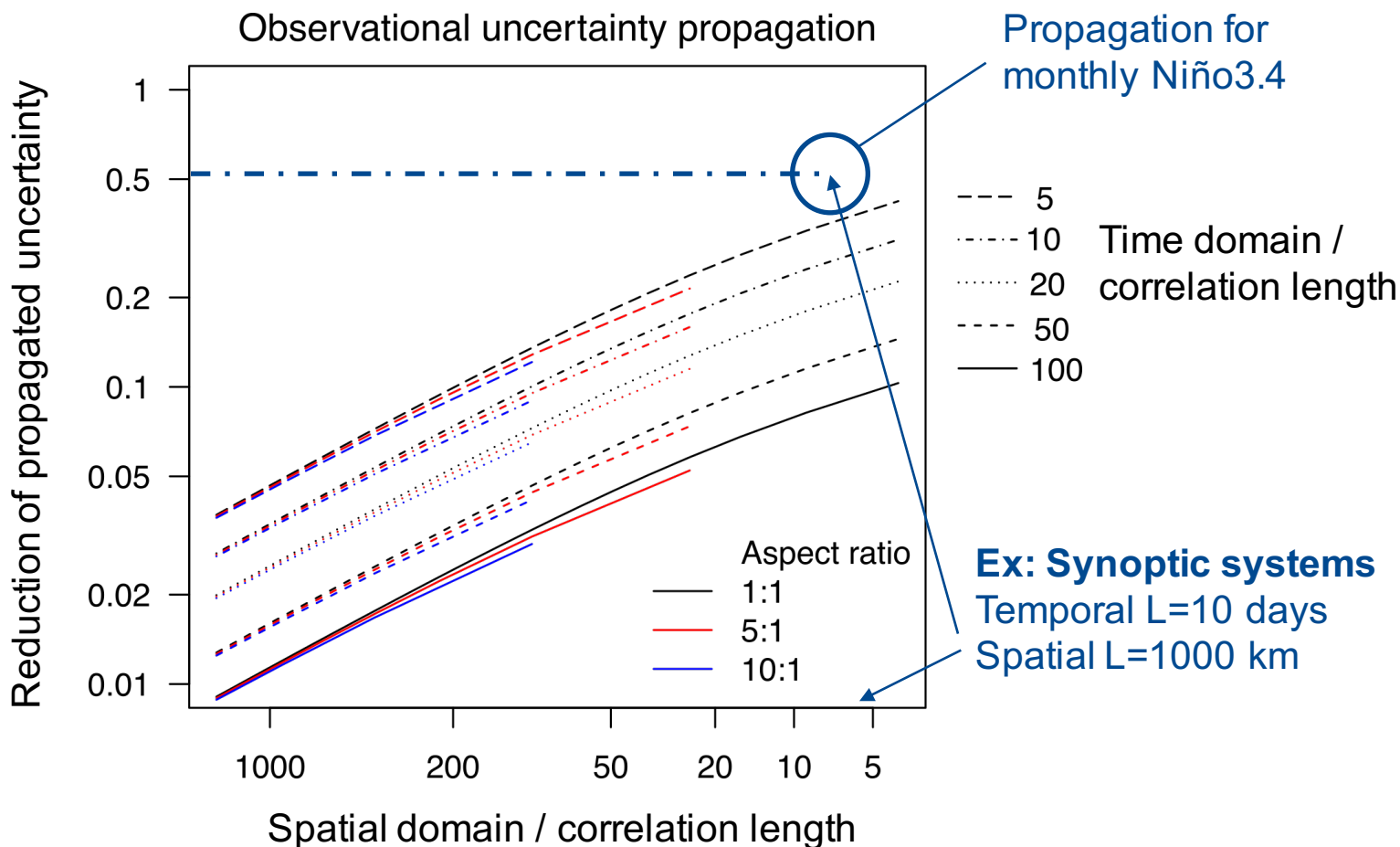
Monthly,  
Niño3.4

Uncorrelated uncertainty  
reduces by  $1/\sqrt{N}$   
but errors are not  
uncorrelated!

Daily, 4 km

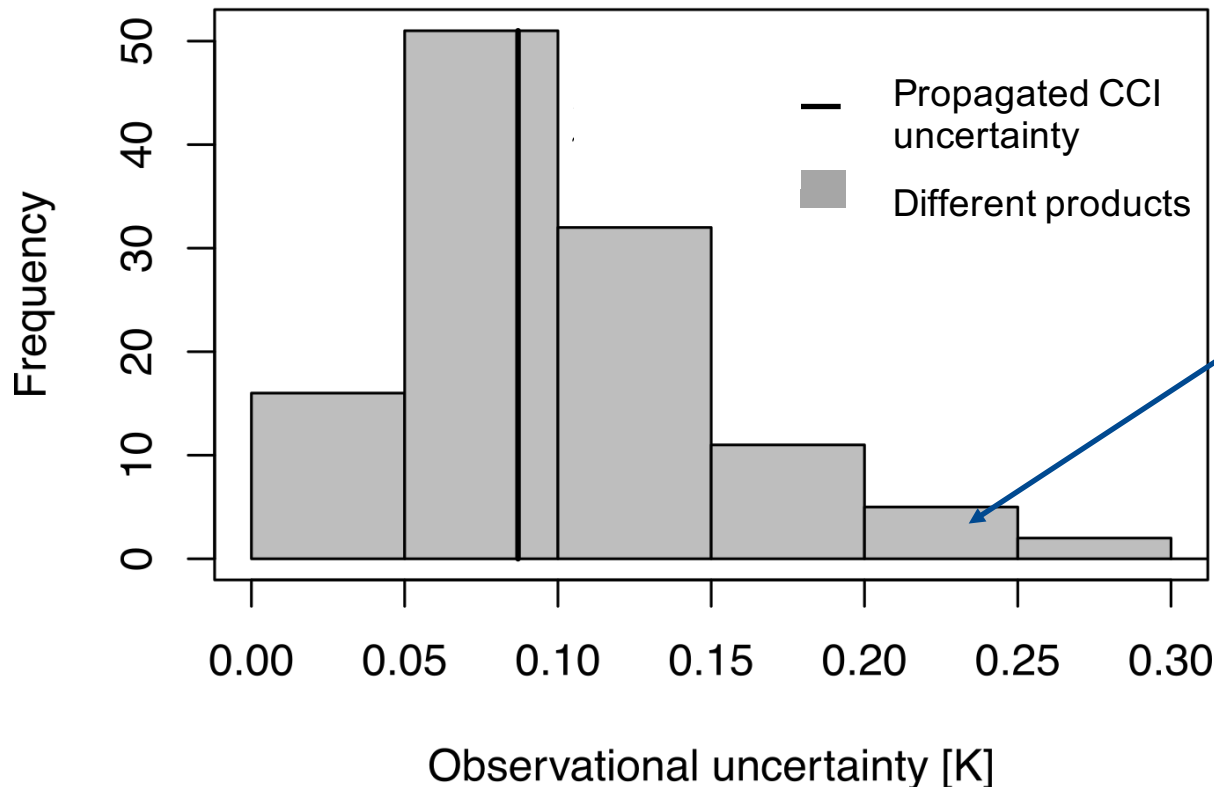
# A “look-up” propagation figure

Use of error correlation scales: analytical solution that allows to look-up propagation factors



**Propagation assuming synoptic scales (1000 km, 10 days) of weather systems agrees well with deviations between existing products**

Observational uncertainty Niño3.4 SST

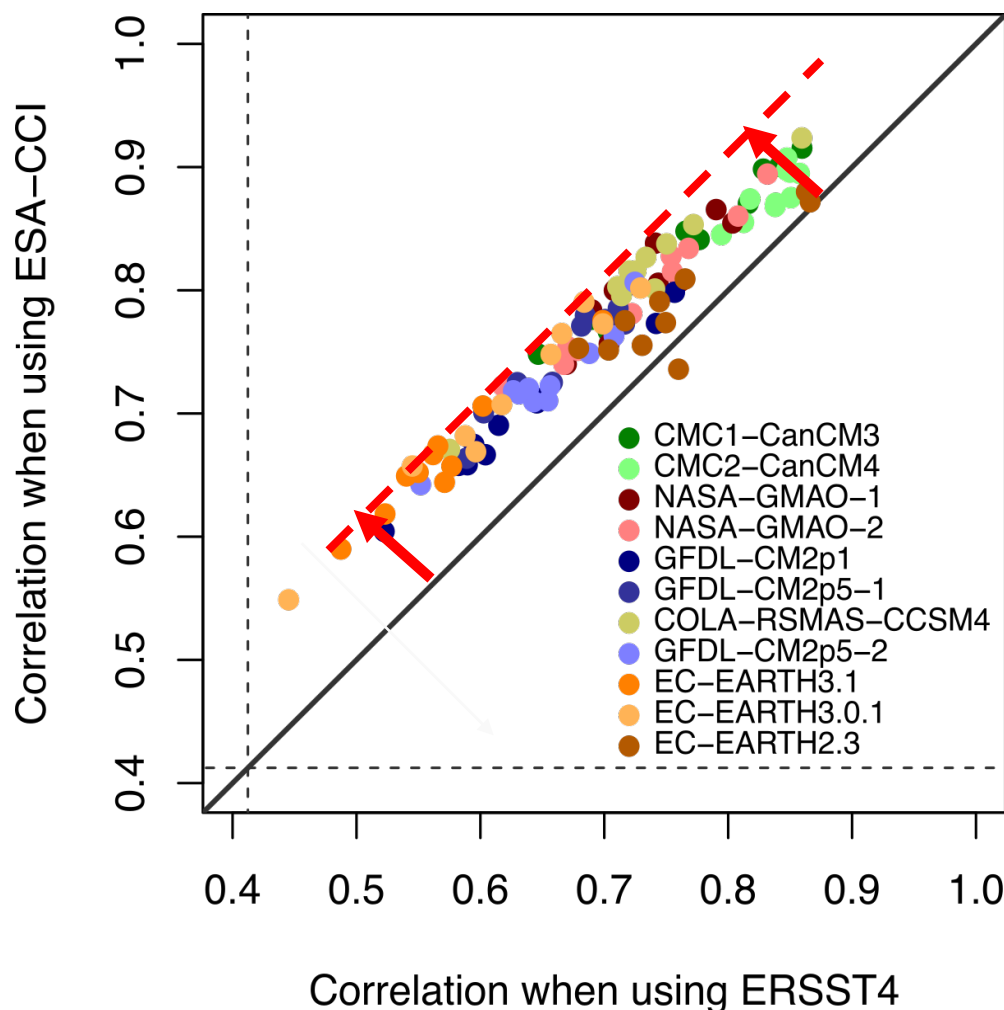


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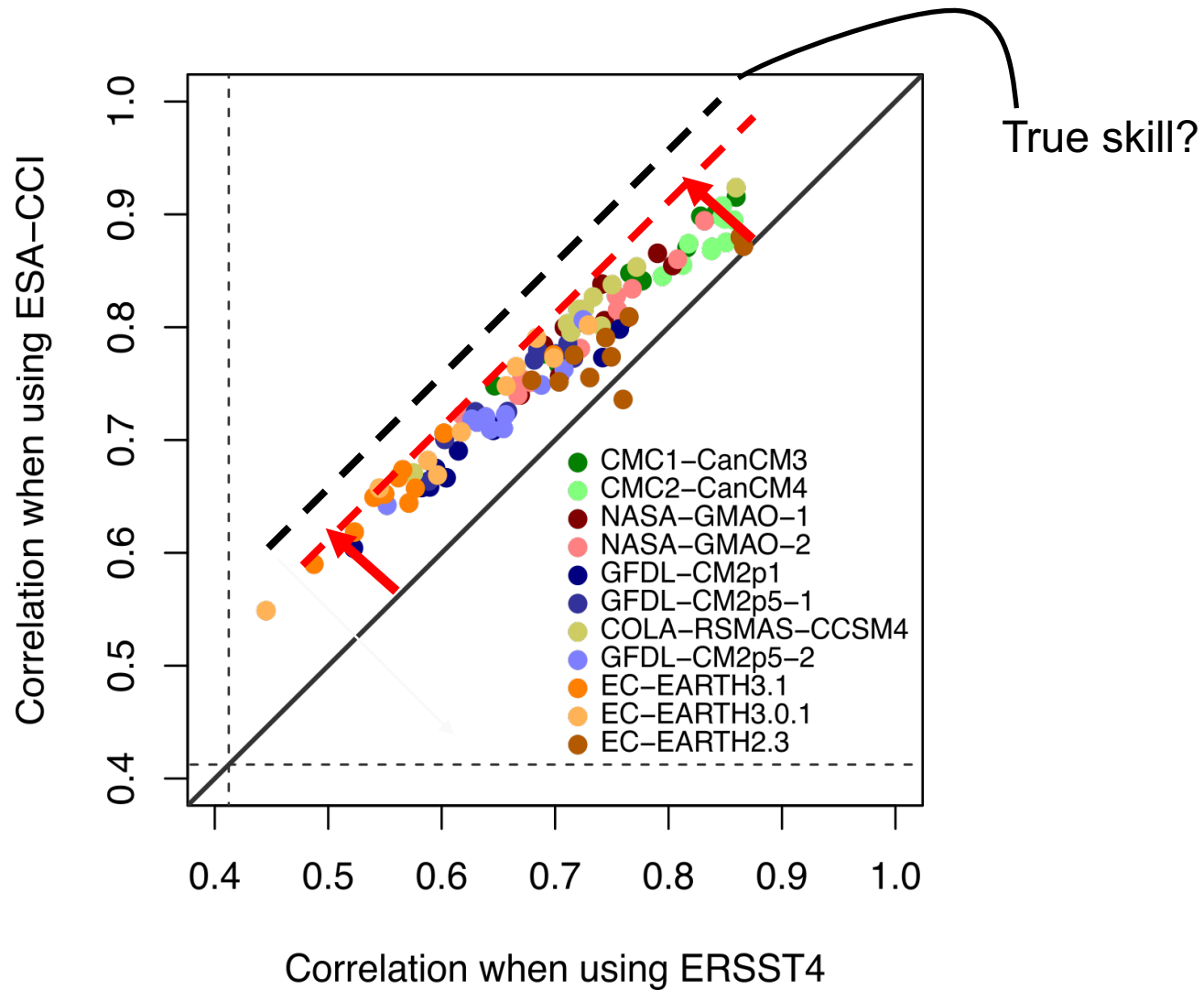
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**CCI SST yields systematic higher correlation skill across many models -> the observational uncertainty is smaller in CCI SST**

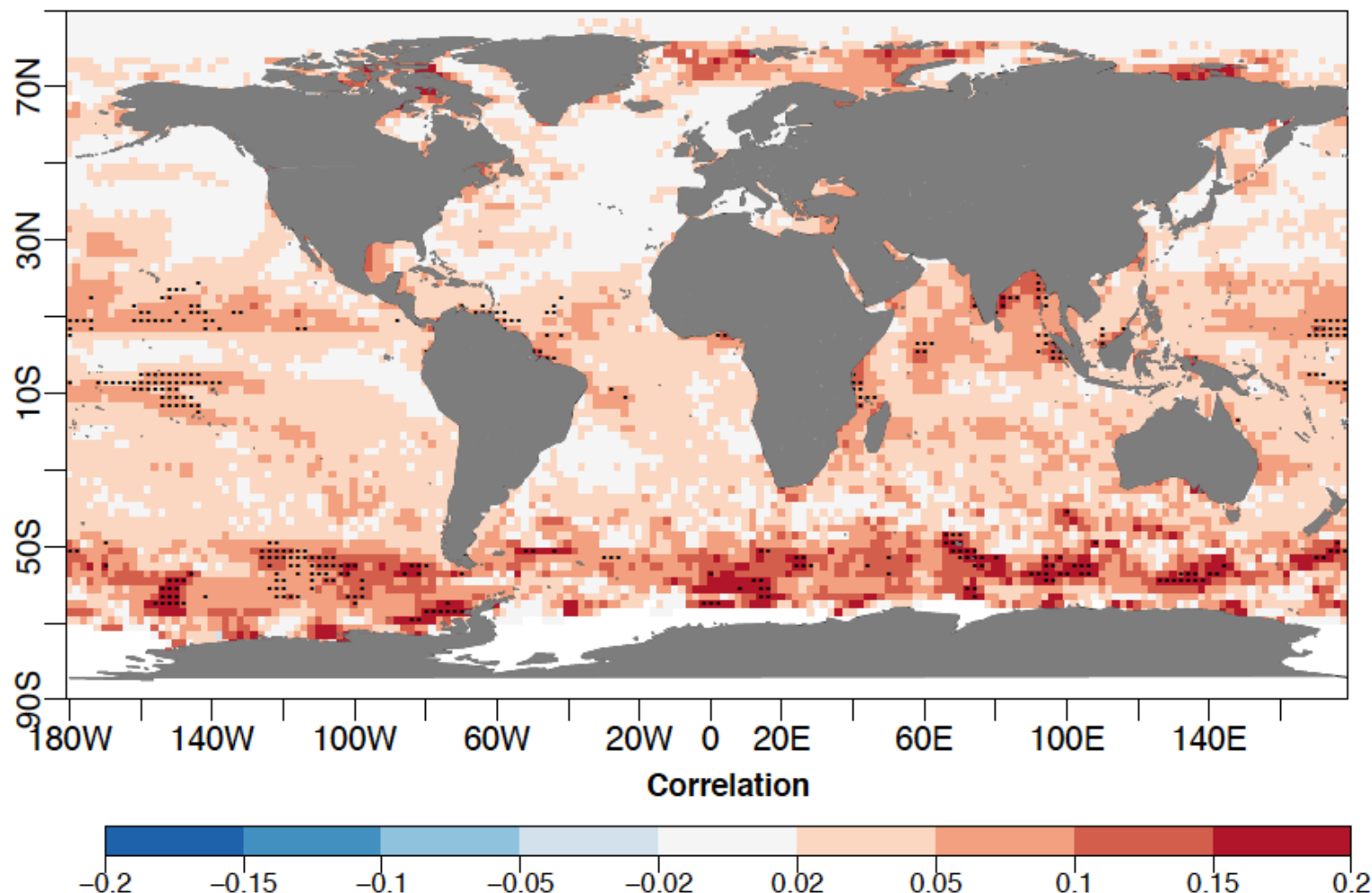


True climate predictions skill is systematically underestimated due to uncertainties in the observations



## Seasonal SST forecast skill is underestimated up to 0.2 correlation

**Lost skill due to observational uncertainty**



## **Acknowledging observational uncertainty opens many new research questions that could be undertaken in CMUG**

- Reverse the verification question: Use multiple climate models to evaluate multiple observations (and their co-variability to other datasets) to measure their quality.
- Apply multi-model ideas to observations: do multi-observations means agree better with the models? Define metrics for model evaluation that allow to account observational uncertainties (e.g. ESMValTool).
- Work on error propagation together with CCI teams, requires strong interactions which will benefit both communities





**Barcelona  
Supercomputing  
Center**

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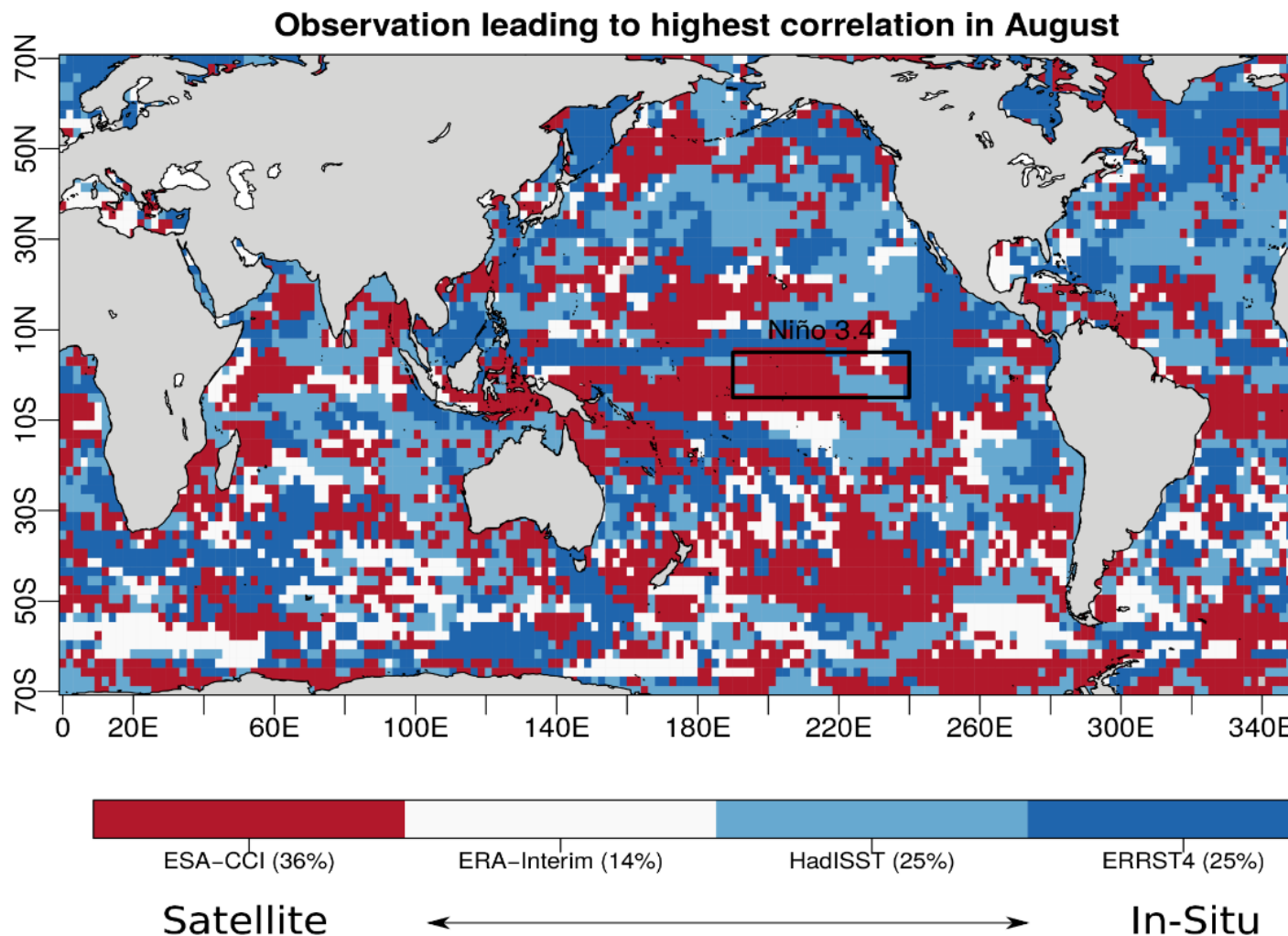
# Thank you!

Bellprat, O., Massonnet, F., Siegert, S., Guemas, V., Doblas-Reyes, F. J. (2017), Exploring observational uncertainty in verification of climate model predictions, *Remote Sensing of the Environment (RSE)*, in review

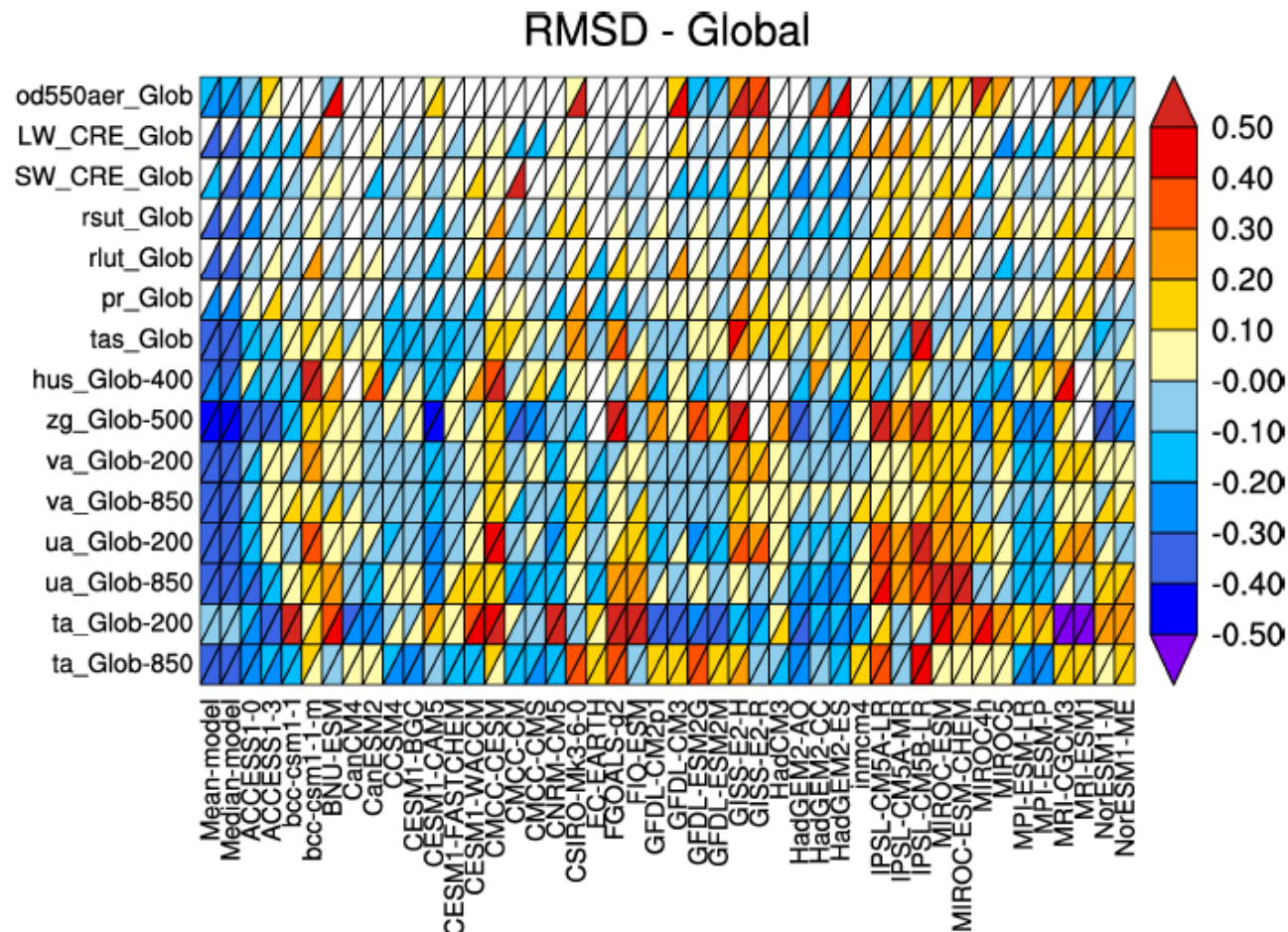
Massonnet, F., Bellprat, O., Guemas, V., Doblas-Reyes, F. J., (2016). Using climate models to estimate the quality of global observational data sets, *Science. (AAAS)*

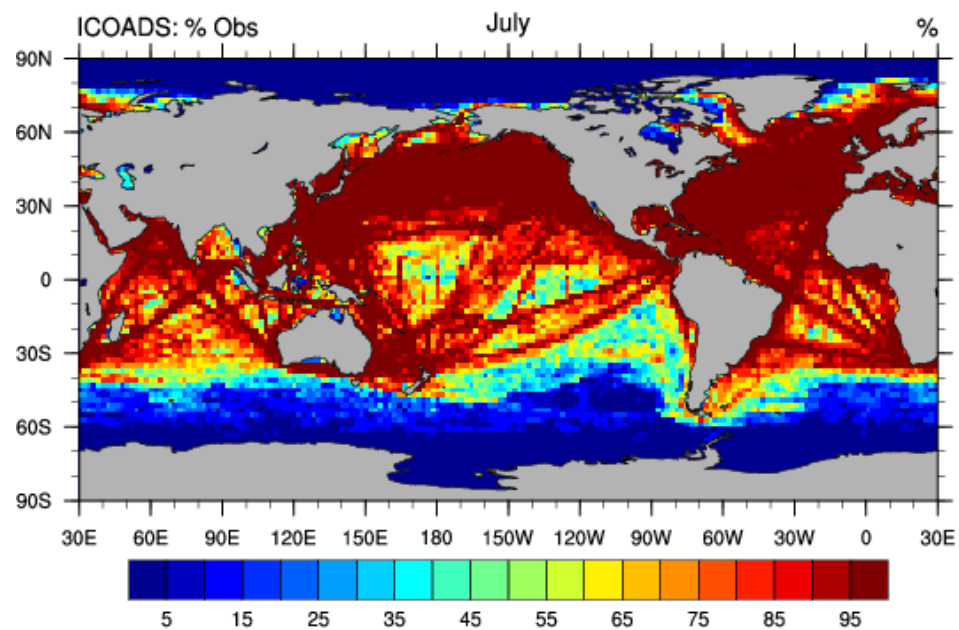
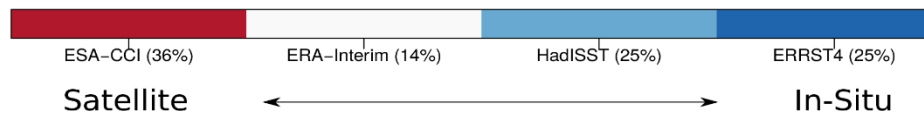
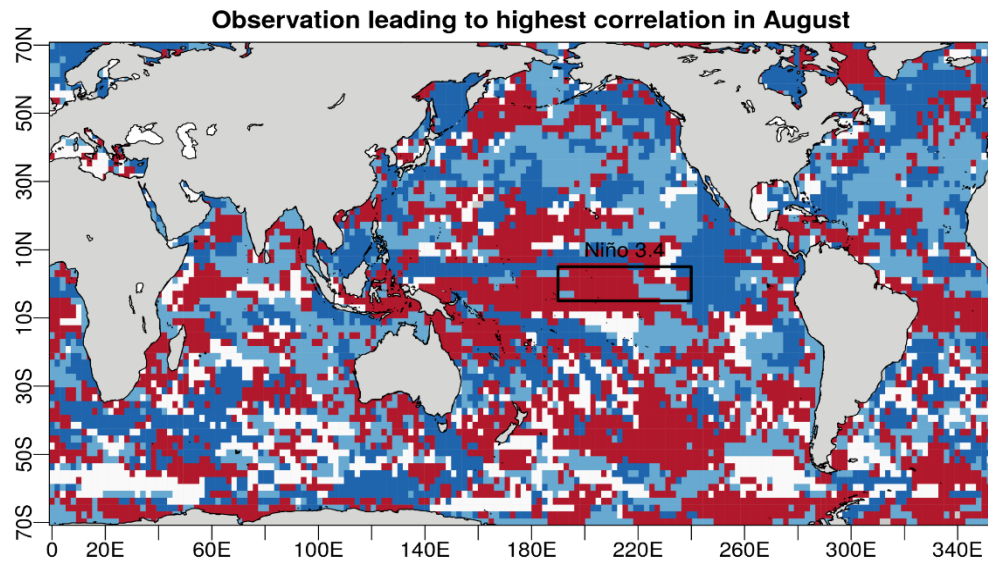
# Extra Slides

CCI SST give also globally on average the highest correlation skill

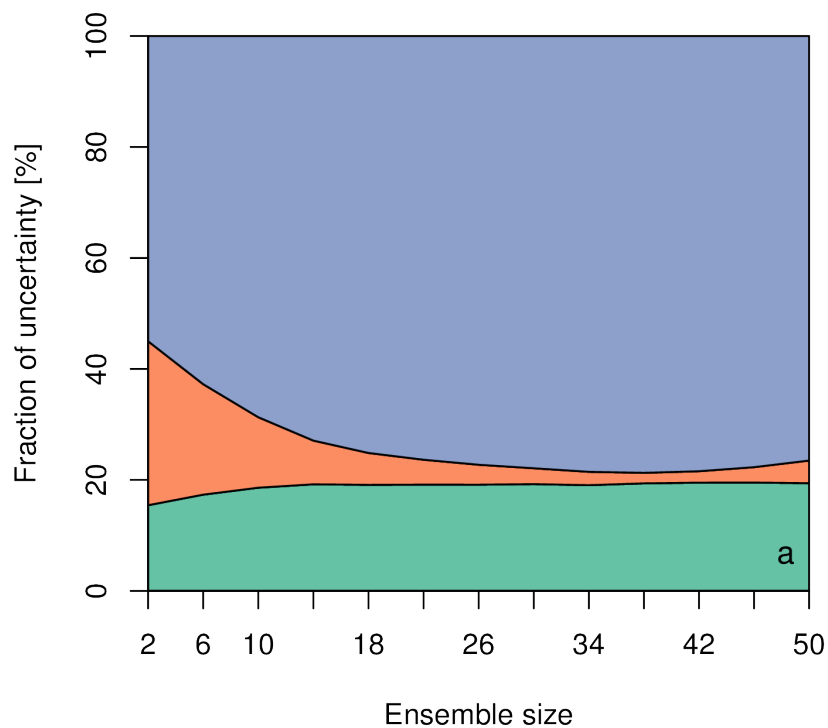


## Consider multi-observation as well as multi-model means

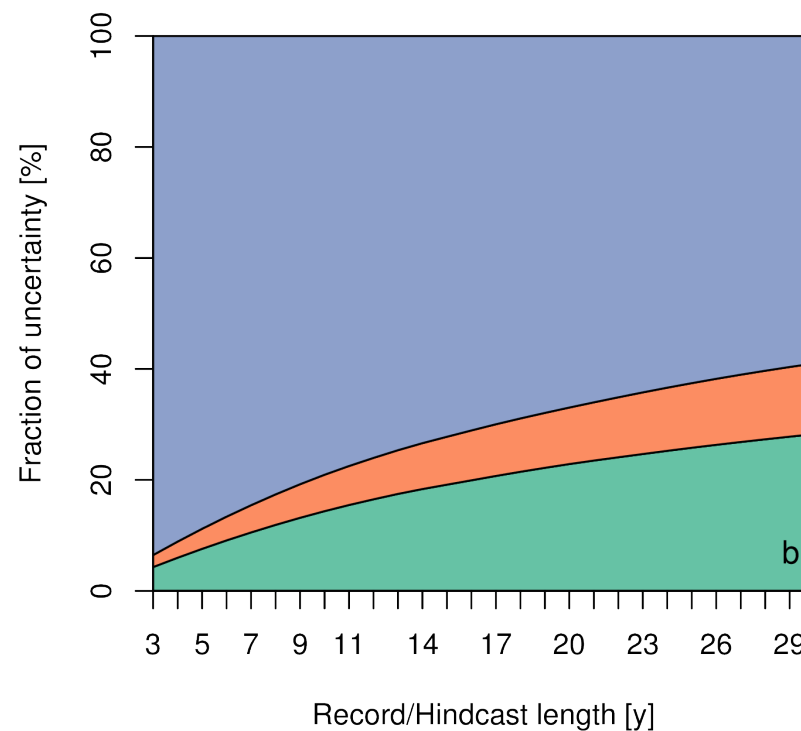




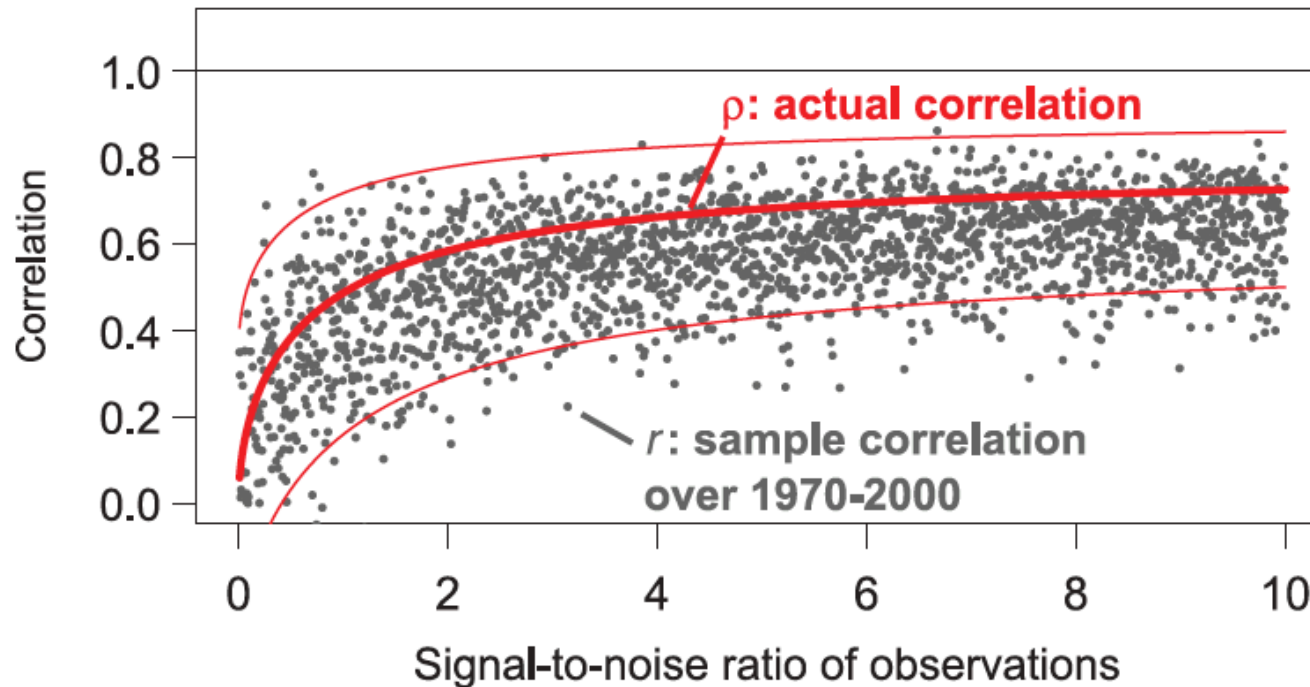
Correlation Uncertainty ENSO



Correlation Uncertainty ENSO



Loss of correlation becomes particularly relevant with signal-to-noise ratios  $< 2$





## Signal (inter-annual variability) versus observational uncertainty (noise)

